BELLCOMM, INC.

SUBJECT: Performance Status for Missions AAP-1/AAP-2 and AAP-3/AAP-4 - Case 600-1

DATE: February 23, 1967

FROM: K. E. Martersteck

ABSTRACT

The current preliminary weight and performance for the first two dual-launch AAP missions is presented. In general positive performance margins do exist, but they are small indeed, especially when the state of definition of the hardware is considered.

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MEMORANDUM FOR FILE

Introduction

The space vehicle configurations for the first two dual-launch AAP missions have been under intensive study and preliminary design since the configuration selection was made last November. During this period, the spacecraft module weights have increased to the point where today there are serious performance problems if all current requirements are to be met. We are still one and one-half to two years before launch and yet payload margins are very small, even negative in some cases. Of course, these numbers are fluctuating from week to week. However, at this point in time it is desirable to have some positive margin to allow for growth during detailed design and fabrication of flight hardware. In this memorandum we will present a flight-by-flight picture of the current weight and performance status for these two AAP missions.

AAP-1 (207)

The CSM and LMSS Payload Module plus rack will be inserted into an 81 x 120 nm orbit. Circularization will be done with the SPS. After about five days of LMSS checkout, the CSM/LMSS will rendezvous with AAP-2 at 270 nm. MSC has been using a launch vehicle capability of 39,900 lbs. inserted by 207 into the 81 x 120 nm orbit, while MSFC has adopted a baseline capability of 40,300 lbs. Nominal J-2 engine thrust of 200K has been used by both Centers for the 207 vehicle. Subsequent uprated Saturn I vehicles will have 205K J-2 engines.

One of the biggest uncertainties on this flight is the LMSS weight. Weights ranging from 4500 to 7850 lbs. have been quoted during the past month. The final LMSS configuration has not been established pending decision regarding the extent of modifications for docking to the Orbital Assembly, for carrying additional experiments and for storage and reuse in earth or lunar orbit. The SPS propellant weights will fluctuate corresponding to the actual LMSS weight. Table I presents the most recent performance and weight figures for AAP-1 along with the source of the figures.

TABLE I

AAP-1 (207)

Payload Weights (lbs)	MSFC	MSC
CSM (Inert)	23,300	23,700
SPS (Propellants)	4,000	4,250
SLA	3,950	3,900
LMSS (With Rack)	6,585	7,850
Total Payload	37,835	39,700
Payload Capability	40,300	39,900
Margin	+2,465	+200

Neither of the CSM weights above include any RCS propellant beyond the current Block II Apollo loading of 1224 lbs. usable. However, the latest estimate by MPAD, MSC, including allowances for rendezvous dispersions and supported by simulations with man in the loop, is that 1793 lbs. of RCS propellant will be needed for AAP-1. Still not included is any provision for backup deboost. Means of augmenting the RCS tank capacity are under consideration at MSC. The "four-on-the-door" modification would provide an additional 1176 lbs. of usable RCS propellant and add 718 lbs. of dry weight. This would reduce the MSC margin for AAP-1 to -1694 lbs.!

AAP-2 (209)

This flight will result in the spent S-IVB stage with the Airlock Module (and Multiple Docking Adapter) being injected into a 270 nm circular orbit. Two parallel and apparently independent design efforts on the Airlock/MDA are being conducted at MSC and MSFC. The result is a disparity in the Airlock/MDA weights projected by the two Centers. Also MSFC has been using a 260 nm orbit for this flight which gives them 900 lbs. additional payload capability. Table II shows the most recent figures for AAP-2 with the MSFC numbers adjusted for a 270 nm orbit.

TABLE II

AAP-2 (209)

Payload Weights (lbs)	MSFC	MSC
SLA	4,100	4,050
Nose Cap	1,067	1,000
AM/MDA	16,155	18,400
Experiments	1,927	1,500
L/V Mods	2,384	2,384
Yaw Steering Reserve		250
Total Payload	25,633	27,584
Payload Capability	27,000	27,050
Margin	+1,367	-534

As indicated above, the heavier MSC Airlock drives their payload margin negative.

AAP-3 (211)

Flight AAP-3 will inject into orbit a CSM and resupply provisions for a 56-day mission. The CSM must rendezvous with the LM/ATM launched on AAP-4 and then rendezvous with and dock to the Orbital Workshop launched on AAP-2. The two Centers propose quite different profiles for this mission.

MSC proposes that the resupply provisions be carried in the Service Module. By removing the SPS storage tanks, two Sectors, in addition to Sectors I and IV, would be available if needed. A solid-rocket retro pack would be added for deboost and the RCS tank capacity augmented. Assuming the "four-on-the-door" modification providing 2400 lbs. total usable RCS propellant, the CSM with resupply provision would weigh an estimated 31,697 lbs. However, the current RCS budget prepared at MSC for the CSM on AAP-3 requires 2624 lbs. which exceeds even the capacity of the augmented system! This RCS budget provides for two rendezvous operations, attitude control for the Orbital Assembly, rendezvous and docking dispersions, and a 6% gauging error. In order to have sufficient performance capability to boost the supply-laden CSM, MSC plans to insert the CSM into an 81 x 120 nm orbit. The SPS would perform subsequent pre-rendezvous propulsive maneuvers.

The MSFC baseline plan assumes a Resupply Module will carry the 56-days' worth of provisions. This means the CSM must first rendezvous with the Orbital Workshop and dock the Resupply Module before proceeding to rendezvous with the LM/ATM. Extrapolating from the MSC RCS budget, this additional rendezvous would probably require 700-800 lbs. of RCS propellant in addition to that required for the MSC mode. The CSM weight given in the MSFC baseline plan makes no provision for any RCS capacity beyond that of the Block II Apollo. In the MSFC plan, the AAP-3 injection orbit is specified to be 81 x 280 nm. If a lower apogee (e.g. 120 nm) were designated and the SPS used for the rest of the main propulsion burns, more than 1000 lbs. extra payload could be made available. The MSFC Resupply Module weight, 6350 lbs., is an allocation for that module, not a design weight.

Table III gives the current weight and performance breakdown for AAP-3.

TABLE III

AAP-3 (211)

	MSFC	MSC
Insertion Orbit	81 x 280	81 x 120
Payload Weights (lbs.)		
CSM (Inert)	23,300	31,697
SPS	4,300	3,500
SLA	3,950	3,900
L/V Mods	500	400
Resupply Module	6,350	
Yaw Steering Reserve		350
Total Payload	38,400	39,847
Payload Capability	38,400	40,740
Margin	0	+893

AAP-4 (210)

This flight will inject the LM/ATM into a 240 nm circular orbit to await rendezvous with the CSM from AAP-3. The most significant difference between MSFC and MSC on this flight lies in their estimates of the LM/ATM weight. This can be seen below in Table IV, which indicates the current weight and performance breakdown for AAP-4.

TABLE IV

AAP-4 (210)

Payload Weights (lbs)	MSFC	MSC
SLA	3,950	4,050
L/V Mods	600	400
LM/ATM	24,072	21,812
Nose Cap	1,067	1,000
Yaw Steering Reserve		250
Total Payload	29,689	27,512
Payload Capability	29,800	29,410
Margin	+111	+1,898

While the two Centers differ slightly on most items, the LM/ATM weight clearly controls the amount of payload margin.

Conclusion

Inspection of Tables I-IV indicates that, for the first four AAP flights, where performance margins do exist they are small indeed, especially when considering that detailed design and hardware fabrication have yet to be done.

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